



*This document contains the Appendix A: for the Indicator Development for Estuaries report. EPA-842-B-07-004. The three studies include:*

*Barataria-Terrebone Bay Program Case Study*

*New Hampshire Estuaries Project Case Study, and the*

*Northeast Coastal Indicators Workshop Case Study*

*The remainder of the document can be downloaded from:*  
<http://www.epa.gov/owow/estuaries/indicators/>

## Indicator Development for Estuaries

February 2008

# **APPENDIX A-1**

## **BARATARIA-TERREBONNE PROGRAM**

### **CASE STUDY**

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#### **PROGRAM OBJECTIVES AND HISTORY**

In September 1990, the State of Louisiana and the U.S. Environmental Protection Agency (EPA) developed a cooperative agreement and formed the Barataria-Terrebonne National Estuary Program (BTNEP). The goal of the program is to launch a collaborative effort that focuses government, private, and commercial resources toward the protection of the basins.

One of the first actions the program initiated was the development of a Comprehensive Conservation Management Plan (CCMP), which detailed specific action plans to promote and preserve the Barataria-Terrebonne Estuary System (BTES). The plan identified issues, assessed status and trends, developed strategies, recommended corrective actions, and implemented and funded plans. Overall, the BTNEP CCMP outlined 12 goals:

- Preserve and restore wetlands and barrier islands
- Realistically support diverse, natural biological communities
- Develop and meet water quality standards that adequately protect estuarine resources and human health
- Promote environmentally responsible economic activities that sustain estuarine resources
- Generate national recognition and support
- Implement comprehensive education and awareness on and awareness programs that enhance public involvement and maintain cultural heritage
- Create an accessible, comprehensive database with interpreted information for the public
- Create clear, fair, practical, and enforceable regulations
- Develop and maintain multi-level, long-term, comprehensive watershed planning
- Be compatible with natural processes
- Forge common-ground solutions to estuarine problems
- Formulate indicators of estuarine ecosystem health and balance estuary use (BTNEP, 1996).

Along with these goals, BTNEP identified seven priority problems causing impacts to the estuary.

1. Hydrologic modification
2. Sediment reduction

3. Habitat loss
4. Eutrophication
5. Pathogen contamination
6. Toxic substances
7. Living resources

When the CCMP was approved by the EPA, an organizational structure was established for the implementation of the program. This included performing day-to-day tasks, reporting information to the public, making policy decisions, and developing meetings and workshops. In 2001, EPA requested that all National Estuary Programs (NEPs) develop indicators to measure the progress of their programs. Based on this request, BTNEP began to develop an indicator set.

### INDICATOR DEVELOPMENT PROCESS

#### Steering Committee Involvement

BTNEP began the indicator development process by forming a planning committee with representatives from Federal, state, and university participants who volunteered their time toward the effort. The committee developed a workshop and formulated background materials. The background workshop materials included goals and objectives of the workshop, initial focus questions, and an indicator selection matrix. The planning committee included the following participants:

- Dean Blanchard, BTNEP
- Rex Caffey, Louisiana State University Agricultural Center
- Rod Emmer, Federal Emergency Management Agency (FEMA)
- Dianne Lindstedt, National Marine Fisheries Service (NMFS)
- Nancy Rabalais, Louisiana Universities Marine Consortium
- Kerry St. Pé, BTNEP
- Greg Steyer, U.S. Geological Survey (USGS)
- Glenn Thomas, Louisiana Department of Wildlife and Fish
- Monica Young, EPA
- Brent Ache, Battelle

#### Identify the Purpose and Need for Indicators

BTNEP's indicator development effort focused on the following purpose and need.

**Purpose:** To develop indicators to periodically review and report the vital signs of the BTES.

**Need:** BTNEP needs to protect, restore, and sustain the BTES for today and for future generations. Indicators are needed to measure the amount of success BTNEP has accomplished toward these goals.

**Issues and Management Objectives**

The issues and management objectives were previously outlined in BTNEP's CCMP. There were then used to develop indicators.

**Baseline Assessment of Each Issue**

Prior to the workshop, the planning committee created an indicator matrix. The matrix was categorized by seven priority problems, and indicators were ranked on level of data availability as high, medium, or low. The matrix also included whether and what type of data were available to support the indicator, as well as the major pro and con considerations for choosing the indicator.

**Indicator Development Workshop**

On June 13-14, 2001, an indicator development workshop was held in Gonzales, Louisiana. The workshop assembled individuals with a vested interest in monitoring or managing BTES who could recommend a suite of indicators that best represents the environmental condition of BTES while also being meaningful to the estuary's residents and public officials.

Workshop participants were separated into four breakout groups for indicator development discussions. Three of the groups were based on the seven priority problems; the fourth group addressed regional demographics, sustained recognition, citizen involvement, and economic growth. The four breakout groups addressed the following issues:

- Hydrologic modification, reduced sediment flows, habitat loss
- Changes in living resources
- Eutrophication, pathogen contamination, and toxic substances
- Quality of life: community, economy, and awareness

Each breakout group was given the same set of goals to develop indicators. They were also instructed to identify indicators to address the specific focus questions. The goals were to:

- Develop a suite of ~20 indicators, maximum, that were both meaningful to the target audience and supported by datasets produced under the current monitoring efforts, that describe:
  - Key components representative of ecological condition related to the seven CCMP priority problems.
  - Key demographic, economic, and awareness components of the region's natural resource-based economy and quality of life.
- Identify potential indicator opportunities based on planned future monitoring in the BTES.
- Identify critical indicator (and associated monitoring) gaps and needs for the BTES.
- Discuss indicators based on the Pressure-State-Response (PSR) framework, which uses stressors, condition, and management actions to categorize environmental indicators.

- Discuss indicator presentation format to present indicators in the indicator report (Battelle, 2001).

### **Indicator Specification and Monitoring**

Indicators were developed based on the focus questions and availability of monitoring data; however, the indicators selected were not necessarily supported by a current dataset or monitoring program. Participants were asked to discuss indicators that either specifically addressed a focus question or were supported by monitoring data. Therefore, three categories were established to group indicators: Supported, Future Indicator, and Gap/Need.

- Supported: Potential indicator by existing status and trends monitoring and assessment.
- Future Indicator: Potential indicator will be supported by planned future status and trends monitoring and assessment.
- Gap/Need: Potential indicator not supported by existing or planned status and trends monitoring and assessment (Battelle, 2001).

The suite of indicators developed at the workshop constitutes the best indicators, currently supported by existing monitoring programs and associated datasets. All indicators selected followed the indicator selection criteria:

### **Valid**

- Relevant: State, pressure, or response indicators relevant to one or more of the seven CCMP priority problems (or the region's natural resource-based economy and quality of life, as addressed in the CCMP).
- Appropriate Scale: Representative of the entire BTES (or some significant sub-unit) over an appropriate time scale.
- Sensitive / Responsive: Natural variability can be reasonably explained; quickly reflects changes in the environment (Battelle, 2001).

### **Understandable**

- Meaningful: Interpretable and meaningful to BTES residents and their political representatives (*i.e.*, simple presentation format).
- Trend: Demonstrates or will demonstrate a trend (increase, decrease, or stable) from a reference condition.
- Measurable: Periodic assessment, on the scale of 1 to 2 years, is supported (Battelle, 2001).

### **Available**

- Supported (or Future): Supporting dataset is long-term trend monitoring, immediately usable, and with a reasonable expectation that monitoring will continue.
- Data Quality: Supporting dataset quality is acceptable.
- Data Provided (Cost Issue): Dataholder agrees to provide the simple data aggregation or the analyzed/modeled results of the dataset (Battelle, 2001).

### **Indicators Developed**

Below is a listing of the focus questions and indicators that participants identified based on available data in the region (Battelle, 2001).

#### **Hydrologic Modification, Reduced Sediment Flows, and Habitat Loss Indicators**

Question 1. Are we losing land in the BTES, and where?

Indicator(s):

- Land-water ratios in the BTES by fresh-, brackish-, intermediate-, and saltmarsh habitat type over time.

Question 2. Why are we losing land in the BTES?

Indicator(s):

- Marsh health and vigor (above and below ground)
- Flooding frequency and duration
- New vertical accretion
- Nutria damage

Question 3. Are fish and wildlife habitats being protected and restored?

Indicator(s):

- Number of acres restored in the BTES over time.

#### **Changes in Living Resources Indicators**

Question 1. Are fish and wildlife populations healthy?

Indicator(s):

- Shrimp abundance in the BTES over time (one of the three significant commercial species, or combined harvest).
- Oyster abundance on public seed grounds in the BTES over time.
- Red drum abundance in the BTES over time.
- Community diversity in the BTES over time (trawl samples).
- Mottled duck abundance in the BTES over time.
- Christmas bird counts over time (which combines both migratory and non-migratory bird species).
- Freshwater catfish abundance in the BTES over time.
- Largemouth bass abundance in the BTES over time.
- Alligator nests in the BTES over time.

Question 2. Are invasive species a problem?

Indicator(s):

- Nutria population and marsh damage estimates in the BTES over time.
- Cost of invasive species control in the BTES over time.

Question 3. Are seafoods safe to eat?

Indicator(s):

- Seafood safety indicator, to be selected from (1) area of oyster closures in the BTES over time; (2) health department fish consumption advisories in the BTES over time; or (3) mercury in edible fish tissue data collected in the BTES.

Question 4. What threatened or endangered species can we use to assess the health of our estuary?

Indicator(s):

- Bald eagle population and nests in the BTES over time.
- Brown pelican population and nests in the BTES over time.

**Eutrophication, Pathogen Contamination, and Toxic Substances Indicators**

Question 1. Are our waters healthy?

Indicator(s):

- Chlorophyll-*a* in the BTES over time.
- Area of dead zone (off coastal Louisiana) over time.
- Number of petroleum spills reports in the BTES area over time.

Question 2. Are pathogen and toxic substance concentrations increasing or decreasing?

Indicator(s):

- Fecal coliform bacteria concentrations at key recreational sites in the BTES over time.
- Fecal coliform bacteria concentrations at key oyster growing water sites in the BTES over time.
- Number of pumpout and dumpstation facilities in BTES over time.
- Number of fish advisories for mercury in the BTES over time.
- Atrazine concentration in BTES surface waters over time.

**Quality of Life: Community, Economic, and Awareness Indicators**

Question 1. How are natural-resource-based business patterns changing?

Indicator(s):

- Value of tourism in the BTES.
- Value of citrus, row crop, cattle, sugar cane agriculture in the BTES.
- Value of oil and gas infrastructure in the BTES and value of product moved through the BTES over time.
- Aggregate dockside value of commercial fisheries landed in BTES parishes over time and number of commercial fishing licenses over time.
- Aggregate landings of recreational fishing in BTES parishes over time.
- Number of recreational fishing guide/charter licenses in the BTES parishes over time.

Question 2. How are environmental changes affecting our quality of life and community's sustainability?

Indicator(s):

- Number and duration of unacceptably high-chlorides in source (input) water to regional drinking water plants (at least Lafourche Parish and Terrebonne Parish plants) over time.
- Value of flood insurance claims in BTES parishes from FEMA over time.

Question 3. How is public support for a healthy estuary changing?

Indicator(s):

- Number of educational brochures distributed annually by the BTNEP over time.
- Number of volunteers participating in the following four programs annually: beach sweep, storm drain stenciling, marsh grass planting, Christmas tree restoration over time.

### **Reporting Indicator Findings**

The findings from the workshop were incorporated into an indicators report (2002), which was distributed to the public, Federal, state, and local agencies. Furthermore, BTNEP plans to release an updated indicators report every 3 years, and it is expected that the indicator list will grow over time as more monitoring data become available.

### **Revision of the Monitoring Program and Indicators**

Prior to development of the indicator report, the focus questions were narrowed down to 10 questions rather than the 12 previous questions developed at the workshop. From the workshop, 38 indicators were developed. However, BTNEP narrowed the indicators to 34, which were reported in the indicator report. BTNEP plans to reassess its indicator program every 5 years.

The information noted throughout this case study came from the following documents and discussions with BTNEP staff.

Battelle. 2001. Workshop Summary: BTNEP Indicators Development Workshop, Holiday Inn, Gonzales, Louisiana, June 13-14, 2001. A publication of the Barataria-Terrebonne National Estuary Program, Thibodaux, Louisiana, June 2001,

BTNEP. 1996. The Executive Summary: Program objectives, action plans, and implementation strategies at a glance. CCMP – Part 1 of 4. June 1996. Available from <http://www.btneep.org/default.asp?id=30>.



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# APPENDIX A-2

## NEW HAMPSHIRE ESTUARIES PROJECT

### CASE STUDY

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#### PROGRAM OBJECTIVES AND HISTORY

The New Hampshire Estuaries Project (NHEP) was formed in July 1995 when the State of New Hampshire and the U.S. Environmental Protection Agency (EPA) developed a cooperative agreement. The program's mission is to protect, enhance, and monitor the environmental quality of the state's estuaries.

The first task that the NHEP initiated was the development of a Comprehensive Conservation Management Plan (CCMP). The plan identified the goals and objectives of the NHEP, assessed status and trends, included research and technical development needs, outlined plan implementation, and identified funding. Overall, the NHEP CCMP (2000) focused on five areas of concern:

- **Water Quality:** Identify and eliminate or reduce pollution sources that degrade water quality.
- **Land Use, Development, and Habitat Protection:** Work with municipalities within the estuaries watershed to ensure that land use policies and new developments consider impacts on estuarine water quality and habitats.
- **Shellfish Resources:** Open shellfish beds that have been closed due to pollution or lack of testing to certify shellfish safety for human consumption.
- **Habitat Restoration:** Protect and restore viable and diverse habitats in the estuarine region.
- **Outreach and Education:** Raise awareness and engage communities, government agencies, organizations, and individuals in responsible use and stewardship of the estuaries.

The CCMP was completed in 2000. The plan presented goals, objectives, and specific actions to protect, enhance, and monitor New Hampshire's estuarine resources. The plan also included a process for implementing the actions, which included organizing tasks, reporting information to the public, making policy decisions, developing meetings and conferences, and securing funds. In 2001, EPA requested that all National Estuary Programs (NEPs) develop indicators to measure the progress of their programs. Based on this request, NHEP began to develop an indicator set.

### INDICATOR DEVELOPMENT PROCESS

#### **Technical Advisory Committee Involvement**

During the fall and winter of 2001-2002, the NHEP Coastal Scientist and Technical Advisory Committee (TAC) developed a suite of environmental indicators to track progress toward the NHEP's management goals and objectives.

The first step toward developing environmental indicators for the NHEP was to translate the goals and objectives from the management plan into questions that could be answered by environmental monitoring. For example, the management plan objective, "Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards" was translated to the question, "Do NH tidal waters meet fecal coliform standards of the NSSP for approved shellfish areas?" For some management objectives, multiple monitoring questions were identified due to the complexity of the factors affecting attainment of the goal. For example, the objective related to achieving water quality that meets shellfish harvest standards depends on reducing both dry-weather and wet-weather pollution sources. Therefore, two additional monitoring questions were developed: "Has wet weather bacterial contamination changed significantly over time?" and "Has dry weather bacterial contamination changed significantly over time?"

The next step was to refine the monitoring questions into a suite of environmental indicators. The difference between environmental indicators and monitoring questions is that indicators have precise definitions of their hypotheses, statistical methods, measurable goals, data sources, data quality objectives, and data analysis methods. Establishing these definitions ensures that the indicators will be interpreted consistently and clearly. As indicators were proposed, they were vetted using the EPA's Office of Research and Development (ORD) guidelines for ecological indicators (EPA, 1999) to determine their level of development.

Finally, the NHEP Coastal Scientist gathered data and prepared a series of indicator reports. The process of working with the data provided more insight and opportunities to refine the indicator definitions.

#### **Purpose and Need for Indicators**

NHEP needed environmental indicators for two purposes. First, indicators are used to report on progress toward management plan goals and objectives. Second, the indicators are used to report on status and trends in water quality and estuarine resources through periodic "State of the Estuaries" reports to the public and other coastal stakeholders.

#### **Indicator Specification and Monitoring**

The TAC followed the ORD guidelines (EPA, 1999) as guidance for developing indicators. The guidelines included:

- **Conceptual Relevance**—Relevance to both the ecological condition and a management question.

- **Feasibility of Implementation**—Feasibility of methods, logistics, cost, and other issues of implementation.
- **Response Variability**—Exhibition of significantly different responses at distinct points along a condition gradient.
- **Interpretation and Utility**—Ability to define the ecological condition as acceptable, marginal, or unacceptable in relation to the indicator results.

### Indicators

According to the NHEP's monitoring plan (2004), the indicators were classified into three tiers based on the above criteria and number of criteria that were met. The three tiers were developed to better define which indicators would answer the monitoring questions stated in the monitoring plan, which in turn report on the progress toward the management objectives.

- **Environmental Indicator**—A parameter that meets all four ORD criteria for developing indicators. The measurable goals set for these indicators are tied to the management goals and objectives. For cases where “baseline” was the measurable goal, the best available baseline data were used, not just data from 2000 (the start date for implementation of the NHEP management plan).
- **Supporting Variable**—A parameter that meets the first three of the ORD criteria but cannot be used to interpret environmental or ecological quality independently. Some of these variables were still considered essential to the NHEP monitoring plan because they provided important information for interpreting trends in other indicators. The difference between supporting variables and environmental indicators is that supporting variables lack measurable goals.
- **Research Indicator**—A parameter that meets the first ORD criteria for being “conceptually relevant” but lacks clear methods and means of interpretation at the present time. Some research indicators were retained in the monitoring plan because they have the potential to address monitoring questions that are not covered by other indicators. NHEP will research these potential indicators in the future.

For some NHEP management objectives, it was not possible to establish environmental indicators because the objective is administrative in nature. “Administrative objectives” describe actions that should be taken rather than environmental conditions to be achieved. Therefore, NHEP's progress on these objectives were tracked by “administrative indicators” that document the activities the NHEP or its partners have undertaken relative to the objective. For example, for the NHEP objective to “encourage 42 coastal communities to actively participate in addressing sprawl,” the administrative indicator reports the number of communities engaged in smart growth activities and the NHEP actions to promote smart growth.

### **Issue and Management Objectives**

Nearly all of the NHEP management objectives (35 of 38, or 92 percent) have been tied to at least one indicator, with a breakdown as follows: 20 of the 38 (53 percent) will be tracked using environmental indicators and 15 of the 38 (39 percent) will be tracked using administrative indicators. For the remaining three management objectives, research indicators have been identified. The NHEP also tracks 18 supporting variables that will be used to help interpret the indicators. In total, the NHEP reports on 34 environmental indicators, 14 administrative indicators, 18 supporting variables, and 10 research indicators. The reason why there are so many more indicators than management objectives (76 vs. 38) is that many objectives have been assigned multiple indicators and supporting variables to answer multiple monitoring questions or to report on different facets of the objective.

### **Environmental Indicators**

The suite of indicators presented in the NHEP monitoring plan (2004) was chosen to answer the monitoring questions discussed in the plan. The indicator's numbers are not listed sequentially as the indicators provided below were chosen by the TAC from a larger set of indicators that were originally developed.

#### **A. Indicators of Bacteria Pollution**

*Monitoring Goal: To determine the status and trends of the sanitary quality of shellfish-growing and recreational waters.*

- BAC1. Acre-days of shellfish harvest opportunities in estuarine waters
- BAC2. Trends in dry-weather bacterial indicators concentrations
- BAC4. Tidal bathing beach postings
- BAC5. Trends in bacteria concentrations at tidal bathing beaches
- BAC6. Violations of *Enterococci* standard in estuarine waters
- BAC7. Freshwater bathing beach postings
- BAC8. Bacteria load from wastewater treatment plants

#### **B. Indicators of Toxic Contaminants**

*Monitoring Goal: To determine the status and trends of toxic contaminants in water, sediment, and biota of coastal New Hampshire.*

- TOX1. Shellfish tissue concentrations relative to Food and Drug Administration standards
- TOX8. Finfish and lobster edible tissue concentrations relative to risk-based standards
- TOX2. Public health risks from toxic contaminants in fish and shellfish tissue
- TOX3. Trends in shellfish tissue contaminant concentrations
- TOX4. Trends in finfish tissue contaminant concentrations

- TOX5. Sediment contaminant concentrations relative to National Oceanic and Atmospheric Administration (NOAA) guidelines
- TOX6. Trends in sediment contaminant concentrations
- TOX7. Benthic community impacts due to sediment contamination

### **C. Indicators of Nutrients and Eutrophication**

*Monitoring Goal: To determine the status and trends of the eutrophic conditions in New Hampshire's coastal and estuarine waters*

- NUT1. Annual load of nitrogen to Great Bay from wastewater treatment facilities (WWTF) and watershed tributaries
- NUT2. Trends in estuarine nutrient concentrations
- NUT3. Trends in estuarine particulate concentrations
- NUT5. Exceedances of instantaneous dissolved oxygen (DO) standard
- NUT6. Exceedances of the daily average DO standard
- NUT7. Trends in biological oxygen demand (BOD) loading to Great Bay
- NUT8. Percent of the estuary with chlorophyll-*a* concentrations greater than state criteria

### **D. Indicators of Shellfish Resources**

*Monitoring Goal: To determine the status and trends of molluscan shellfish populations in New Hampshire's coastal and estuarine waters.*

- SHL1. Area of oyster beds in Great Bay
- SHL2. Density of harvestable oysters at Great Bay Beds
- SHL3. Density of harvestable clams at Hampton Harbor flats
- SHL4. Area of clam flats in Hampton Harbor
- SHL5. Standing stock of harvestable oysters in Great Bay
- SHL6. Standing stock of harvestable clams in Hampton Harbor
- SHL7. Abundance of shellfish predators
- SHL8. Clam and oyster spatfall
- SHL9. Recreational harvest of oysters
- SHL10. Recreational harvest of clams
- SHL11. Prevalence of oyster disease
- SHL12. Prevalence of clam disease

### **E. Indicators of Land Use and Development**

*Monitoring Goal: To determine the status and trends of land use and development in coastal New Hampshire.*

1. LUD1. Impervious surfaces in coastal subwatersheds
2. LUD2. Rate of sprawl—high impact development

3. LUD3. Rate of sprawl—low-density, residential development
4. LUD4. Rate of sprawl—fragmentation

#### **F. Indicators of Habitat Protection**

*Monitoring Goal: To determine the status and trends of habitat protections in New Hampshire's coastal and estuarine waters.*

- HAB6. Protected conservation lands
- HAB3. Protected, undeveloped shorelands
- HAB4. Protected, unfragmented forest blocks
- HAB5. Protected rare and exemplary natural communities

#### **G. Indicators of Critical Habitats**

*Monitoring Goal: To determine the status and trends of critical species and habitats in New Hampshire's coastal and estuarine waters.*

1. HAB1. Salt marsh extent and condition
2. HAB2. Eelgrass distribution
3. HAB11. Unfragmented forest blocks

#### **H. Indicators of Critical Species**

*Monitoring Goal: To determine the status and trends of critical species in New Hampshire's coastal and estuarine waters.*

1. HAB7. Abundance of juvenile finfish
2. HAB8. Anadromous fish returns
3. HAB9. Abundance of lobsters
4. HAB10. Abundance of wintering waterfowl

#### **I. Indicators of Habitat Restoration**

*Monitoring Goal: To determine the status and trends of habitat restoration in New Hampshire's coastal and estuarine waters.*

1. RST1. Restored salt marsh
2. RST2. Restored eelgrass beds
3. RST3. Restored oyster beds

### **Reporting Indicator Findings**

The NHEP publishes four data reports (“indicator reports”) that illustrate the status and trends in the various indicators. These reports are technical in nature. Each report focuses on a different suite of indicators: shellfish, water quality, land use and development, and habitats and species. All of the indicators are presented to the TAC, which selects a subset of indicators to be presented to the NHEP management committee. After the chosen indicators are presented to the committee, between 10 and 20 indicators are chosen to be included in the “State of the Estuaries” report. This report is published every 3 years.

The combination of the technical reports for the scientific community and the simpler State of the Estuaries report for other users is useful for getting indicator information to as many people as possible.

### **Monitoring Program**

The NHEP developed a monitoring plan for each indicator. The data quality objectives for each indicator were matched to an appropriate sampling and analysis design using power analysis. Sampling design details are listed in the NHEP monitoring plan.

### **Indicator Implementation**

The NHEP TAC is tasked with initiating, overseeing, tracking, evaluating, and updating the implementation of the monitoring plan. According to the NHEP monitoring plan (2004), the plan will be “fully implemented” when the NHEP is able report on at least one indicator for each management objective. Currently, 35 of 38 management objectives are tied to at least one indicator.

### **Formal Adoption and Funding**

The latest version of the NHEP monitoring plan (version 4) was approved by the NHEP TAC in June 2004. This plan contains forecasts of funding needs through 2015. The NHEP uses these forecasts to allocate monitoring funds each year.

### **Communication**

The NHEP’s goal is to communicate the results of environmental monitoring to four audiences: the EPA, the NHEP Management Conference, the scientific community, and the public, which is broadly defined to include coastal decision-makers, watershed organizations, and interested citizens.

### **Data Collection and Analysis Plan**

The NHEP monitoring plan contains information on data collection and analysis for each indicator. As with most of the NEPs, the NHEP coordinates with agencies and organizations who participate in monitoring activities in order to avoid duplication of effort. This coordinated effort makes the most of current monitoring efforts and available data. The NHEP maintains the inventory of all estuarine and coastal monitoring programs in the state. The NHEP monitoring plan incorporates data collected by over a dozen programs.



### **Revision of the Monitoring Program and Indicators**

The NHEP Coastal Scientist and TAC review the monitoring programs and indicators each year. The monitoring plan is updated periodically as new indicators are developed or monitoring programs change.

The information noted throughout this case study came from the following documents.

NHEP. 2000. Comprehensive Conservation Management Plan. New Hampshire Estuaries Project. 2000.

NHEP. 2002. Environmental Indicator Report: Water Quality. New Hampshire Estuaries Project. December 27, 2002.

NHEP. 2003. Environmental Indicator Report: Land Use and Development. New Hampshire Estuaries Project. April 30, 2003.

NHEP. 2003. Environmental Indicator Report: Species and Habitats. New Hampshire Estuaries Project. April 30, 2003.

NHEP. 2003. Environmental Indicator Report: Shellfish. New Hampshire Estuaries Project. October 14, 2003.

NHEP. 2003. The State of the Estuaries. New Hampshire Estuaries Project. September 2003.

NHEP. 2004. Monitoring Plan. New Hampshire Estuaries Project. June 2004.

All NHEP documents can be downloaded from [www.nhep.unh.edu](http://www.nhep.unh.edu).

# APPENDIX A-3

## NORTHEAST COASTAL INDICATORS

### WORKSHOP CASE STUDY

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In 2001, representatives of Federal, state, local and non-governmental organizations (NGOs) from eastern Canada and the New England region met to discuss issues that were common throughout the Gulf of Maine region. Their vision was of a sustainable Northeast Atlantic ecosystem that ensures environmental integrity and that supports and is supported by economically viable, healthy human communities. Based on this initial discussion and the need for information on the ecosystem, an idea was spawned to form a coordinated regional program to monitor the coastal waters from eastern Canada to the Long Island Sound region of New York. This particular situation was unique because it was not mandated by Federal or state regulations, but a collaborative idea among environmental managers of the region. The overall goal that developed was a group, which would voluntarily coordinate their current monitoring programs to determine the overall ecological health of the northwest Atlantic region.

In 2002, the group began to formally discuss what the program would focus on and whether organizations throughout the region felt a coordinated program could be developed. The first step was development of a steering committee, which included staff from various Federal, provincial, and state governments throughout the northeast United States and eastern Canadian region. The committee initially chose to focus on three areas of coastal environmental monitoring: nutrient overenrichment; toxics/contamination; and habitat loss, degradation and restoration. Participants of the steering committee focused their efforts on developing a straw coordinated regional monitoring strategy and collecting information on current monitoring, regional concerns, and future focus areas (*e.g.*, questions that should be answered through the coordinated monitoring effort).

The information development step included the preparation of white papers and other documents by the steering committee for each of the three focus areas. This information was presented to a larger contingency of environmental managers, policy-makers, scientists, and the region's public at the first of two workshops held in December 2002. At the workshop, the steering committee presented its ideas for a regional coordinated monitoring program and why it thought such a program would be important to the region. The group was also brought together to:

- Develop an ecologically driven basis for coordinating selected monitoring programs in Atlantic Northeast coastal waters,
- Develop a framework for a regional monitoring network, and
- Identify new regional monitoring needs and corresponding research needs that respond to the region's pressing management needs.

The major conclusion from the workshop was that a coordinated regional monitoring network was needed and could be developed. Participants recommended that the coordinated regional monitoring network be set up with the following form and functions:

Form:

1. Geography—Nova Scotia/New Brunswick to Long Island Sound. Additional information from other areas may be needed to support some parameters (*e.g.*, atmospheric deposition).
2. Type of organization—regional public/private nonprofit or charitable organization that incorporates existing mandates.
3. Partners—government, NGOs, businesses, academics, regional organizations.
4. Structure—steering committee or board that includes state/provincial agencies, environmental groups, dischargers, researchers, and the public.
5. Governance/decision-making—where appropriate voluntary compliance, consensus, and legislative mandates (existing and new).
6. Operating budget—start with seed funding; then, after positive results have been shown, plan on incremental growth. If funding becomes available, move toward major initiatives.
7. Funding sources—new grants and contracts (*e.g.*, government, foundations). Larger monitoring groups involved would use some of their resources toward involvement in the program in return for additional information on areas of concern.
8. Staffing—focused full-time regional coordinator growing to additional staff.

Function:

1. Scope/reach—government, volunteer, and academic programs and more as appropriate to answer the questions.
2. Scale—depends on the final questions being asked.
3. Links to research—identifies priorities linked to monitoring; active proponent of regional research; identifies new issues and problems.
4. Program design and implementation/methods—coordinate programs to meet regional needs; apply performance-based standardized protocols as appropriate.
5. Data management—start with web links to databases with spatial references and metadata. As the program proceeds, standardized formats for data and policies for making data available and reported should be developed.
6. Data synthesis and communication—integrated multifactor regional assessments with links to management, public, and NGO needs; educational and marketing materials; and smaller-scale assessments or larger trends and assessments by selected issues.
7. Services provided—regional multivariate

Although other programs integrate regulatory and management needs and responsibilities into their programs, the consensus of the participants was that this regional program

should not go beyond coordinating, collecting, and disseminating monitoring data. Instead, a coordinated monitoring group could first provide data that regulators would find useful in assessing water quality and management needs. If the regional program provides useful advice and creates a valuable forum for discussion on how each jurisdiction can better manage their waters or make recommendations for comprehensive management that cannot be handled at the state/province level, regulators should be more open to participation.

For this program to work, the participants felt that the major monitoring groups needed to be involved in this process. These included: the U.S. Environmental Protection Agency's (EPA's) National Coastal Assessment (NCA), the Gulf of Maine Ocean Observing System (GOMOOS), Gulfwatch, Plum Island Sound Long Term Ecosystem Research, the Massachusetts Water Resources Authority (MWRA), National Estuary Programs (NEPs), National Estuarine Research Reserves (NERRs), the National Park Service (NPS), aquaculture monitoring programs, and industry (*e.g.*, power plants, manufacturing). Participation by large monitoring programs was noted as being necessary to provide the critical mass needed to move forward. This does not mean that other smaller programs or new programs are not needed. However, due to the lack of funding in most areas, data will need to be extracted from existing programs, and then augmented where needed.

Based on the conclusions from this workshop, the steering committee was expanded and a set of goals created to further the development of the program. The expanded committee initially focused on getting the message of its efforts out to monitoring programs throughout the region. The committee also used the information collected at the workshop to develop conceptual models, questions, and information on possible indicators throughout the region. The committee refined the focus on the three issues addressed by the workshop to include fisheries, land use, and climate change issues.

This information was used to support a second workshop, conducted in January 2004, that focused on gaining consensus on a list of key indicators for which regional data would be compiled and used to track trends in ecosystem integrity through the Northwest Atlantic region. This workshop focused on:

- Reviewing current efforts to coordinate monitoring and indicator development throughout the region.
- Developing indicators that apply to the northeast coastal region of the United States (from New York to Maine) and Canada (Gulf of Maine) under six categories: fisheries, eutrophication, contaminants, coastal development, aquatic habitat, and climate change.
- Discussing how indicators could be created and managed, including incorporation into existing programs, in the near future.
- Informing area agency managers of the results of the workshop to get buy-in on the necessity of the coordinated program and to collect information on what the managers need from the program.

Participants discussed the progress made to develop the coordinated regional program and what should be done to get the program formally started. In addition, key managers from several of the top agencies and organizations throughout the region were invited to hear the findings and suggestions of the workshop and to provide input on next steps that might ensure successful program implementation.

After this workshop, a Memorandum of Understanding (MOU) was developed and distributed among interested programs. It focused on sharing data for the coordinated effort. Members of the steering committee also took on additional tasks to move the program forward.

### INDICATOR DEVELOPMENT PROCESS

#### **Steering Committee Involvement**

For this effort, the steering committee was a key success factor in developing a coordinated monitoring network with indicators. Commitment of staff time by agencies and organizations from each of the states and provinces proved to be the major catalyst in the design and development of this program. The steering committee included participants from:

- Battelle
- Connecticut Department of Environmental Protection
- Environment Canada
- Maine Department of Environmental Protection
- Maine Sea Grant Program
- Maine State Planning Board
- Massachusetts Coastal Zone Management
- MWRA
- National Oceanic and Atmospheric Administration (NOAA)
- National Marine Fisheries Service (NMFS)
- EPA Headquarters
- EPA Region 1
- U.S. Geological Survey (USGS)
- Wells NERR

Members of the steering committee were responsible for assisting with the development and design of the regional network, but they also assisted in informing their managers and others of the importance and usefulness of this program. Each member worked hard to make this program a success. Some assisted by developing materials for the workshop to communicate the overall goals of the program, but also the necessary information to make decisions towards those goals. Others assisted by taking the message of coordination to others to get programs interested in being a part of the network; still others helped by trying to find funding for the program. Without the assistance of each person, the program would not have moved forward.

### **Purpose and Need for Indicators**

The steering committee determined the purpose of this program to be to track the status and trends in ecosystem integrity throughout the Northwest Atlantic region through collaborative partnerships. The need of the program was to provide information for policy, management, and advocacy decisions at a regional scale.

### **Identify the Issues**

Several environmental issues are widespread in the region. Early in the development process, the steering committee decided to focus on a limited number of the issues. The plan was to start with a limited number and add additional topics as the program progressed. Initially three topics were chosen based on the *Gulf of Maine Council on the Marine Environment Action Plan 2001 to 2006* ([http://www.gulfofmaine.org/council/action\\_plan/action\\_plan2001-06.pdf](http://www.gulfofmaine.org/council/action_plan/action_plan2001-06.pdf)). Nutrient overenrichment, toxics/contamination, and habitat loss, degradation and restoration were covered at the first workshop in December 2002. Participants of the first workshop voiced concern with three additional topics: fisheries, land use, and climate change. Based on the request from workshop participants, these three additional topics were included in the second workshop held January 2004, along with the first three topics from the initial workshop.

### **Assessment of Each Issue**

Each issue included in the process was assessed by reviewing available literature and compiling the information into a statement of present status. In most instances, monitoring programs throughout the region had reports noting the status of individual areas of the region, which were used to extrapolate an overall picture of the region. Although a measurable baseline could not be specified, in most instances enough information for the region was available to allow future changes, either beneficial or adverse, to be noted.

As noted earlier, the steering committee developed straw documents on the issues, questions, and possible indicators that could be used to track these issues throughout the region. They also collected information on monitoring programs throughout the region along with information on the types of data each program collected.

### **Conceptual Models**

Conceptual models were developed by the steering committee in a variety of formats. Some were written descriptions, while others were tables or pictures. Common to each of the models was the fact that they noted pressures to the system, the current state of the system as it was known at that time, and the response of the system to the pressures exerted on that system. Figure 8 within the main body of this manual was one of the models developed.

### **Indicators**

The focus of the January 2004 workshop was the review of questions that needed to be answered by the program and indicators that could possibly supply the necessary data to evaluate changes in each of the six topic areas. Below is a listing of the questions and

indicators that participants suggested the network focus on answering in their initial efforts, based on available data from the region.

### **Fisheries**

Overarching Question: What is the health of the fisheries with regard to ecosystem integrity, including targeted and non-targeted species, habitat, and fisheries activities?

Question 1. What are the trends in and the status of exploited fisheries stocks?

Indicator(s):

- Proportion of stocks at or above targeted abundance or biomass
- Age/size structure of species from surveys and/or landings
- Spatial distribution of fisheries species

Spatial and Temporal Scales: Range of species or stocks; annual to every 3-5 years

Question 2. What are the effects of fishing on non-targeted species and their associated communities?

Indicator(s):

- Characteristics of bycatch and discards
- Population levels for selected species
- Species diversity

Spatial and Temporal Scales: Regional based on populations or stock, biogeographic boundaries; seasonal

Question 3. What are the effects of fishing and non-fishing activities on marine habitat and fisheries productivity?

Indicator(s):

- Area closed to fishing, both pelagic and/or benthic
- Benthic diversity
- Spatial distribution of bottom fishing

Spatial and Temporal Scales: Region-wide (based on biogeographic boundaries); 1 to 5 years, depending on habitat to annually to continuous

Question 4. What are the trends in the socioeconomic characteristics of fishing?

Indicator(s):

- Days at sea
- Fleet composition
- Commercial and recreational fishing economic value
- Angler satisfaction
- Overcapitalized fleets
- Natural capital value
- Market value for consumers

### **Contaminants**

Question 1. How are contaminants in the region changing?

Indicator(s):

- Area of sediments that have contaminant levels above sediment quality guidelines
- Level of contaminants in representative non-migratory organisms
- Area of shellfish bed closure by state by year
- Days of beach closure due to bacterial contamination by state by year

Spatial and Temporal Scales: Specific water body scales; event to annual to decadal

Question 2. How is the input of contaminants changing over time and space?

Indicator(s):

- Annual chemical load to water bodies by state
- Number of bacterial source investigations and sources eliminated by year by state

Spatial and Temporal Scales: Water bodies region-wide; annual to source specific

Question 3. Are management actions changing the extent and severity of human health effects?

Indicator(s):

- Incidences of human disease caused by consumption of fish and shellfish and recreational contact
- Level of contaminants in representative fish/shellfish and at-risk humans
- Annual number of beach and shellfish closures (reopenings)

Spatial and Temporal Scales: Water bodies region-wide; annual to source specific

Question 4. How well are contaminant management actions protecting ecosystem integrity?

Indicator(s):

- Sediment quality measure by triad approach
- Incidence of disease
- Reproductive success
- Quality of habitats as affected by contaminants

Spatial and Temporal Scales: Water bodies region-wide; annual to decadal scales

### **Eutrophication**

Question 1. What are the extent, severity, and trends of eutrophication impacts?

Indicator(s):

- Dissolved oxygen (DO)
- Chlorophyll-*a*
- Submerged aquatic vegetation
- Water clarity

Spatial and Temporal Scales: Estuary-wide; seasonal to annual



Question 2. What are the sources of nutrients, can they be controlled, how are they changing?

Indicator(s):

- Measured and modeled loads
- Land use/cover (load proxy)
- Population (load proxy)

Spatial and Temporal Scales: Regional; seasonal to annual to decadal

Question 3. What is the state of management measures and how can they be optimized?

Indicator(s):

- DO
- Chlorophyll-*a*
- Submerged aquatic vegetation
- Water clarity
- Measured and modeled loads
- Land use/cover (load proxy)
- Population (load proxy)

### **Aquatic Habitat**

Question 1. How is the extent, distribution, or use of coastal habitats (watersheds, estuaries, near, and offshore) changing over time?

Indicator(s):

- Extent per habitat type over time
  - Large-scale mapping, small-scale ground surveys
- Distribution per habitat type
- Inventory of human use
  - Area, percent of public vs. private
  - Area, percent designated for permanent habitat protection

Question 2. How is the ecological condition of coastal habitats changing over time?

Indicator(s):

- Community structure
  - Measure of change of relative abundance of species within habitat
- Trophic structure
- Species of concern

Question 3. What are the causes of coastal habitat change over time?

Indicator(s) of most important potential causes of habitat loss and degradation (physical and hydrologic alteration, nutrient loading, resource extraction, contaminants, climate change, sediment input)

- Extent and percent habitat area altered by tidal restrictions
- Boat registrations
- Seagrass Nutrient Pollution Index
- Indicators relating to other causes assumed covered by other groups

### **Coastal Development**

Question 1. What is the type, pattern, and rate of land use change?

Indicator(s):

- Percent change in land cover to more intensive uses
- Demographic changes (population, etc.)
- Types of land uses and change

Question 2. How are these changes impacting the integrity of coastal ecosystems?

Indicator(s):

- Integrity of coastal ecosystems for:
  - Threatened and endangered coastal species
  - Migratory species
  - Invasive species

Question 3. How is the region responding to changes in coastal ecosystems?

Indicator(s):

- Type, location and pace of land conservation
- Type, location and pace of habitat restoration
- Land management (planning, regulatory, etc)

### **Climate Change**

Question 1. What are the causes?

Indicator(s): None identified

Question 2. What are the impacts of climate changes to: weather, atmospheric & ocean circulation, ecosystems, and society?

Indicator(s):

- Precipitation trends
- Storm frequency and intensity
- Water temperature surface bottom
- Relative sea level rise

Spatial and Temporal Scales: Regional; annual to decadal

Question 3. What are the impacts of climate change on biotic ecosystems?

Indicator(s):

- Warm vs. cold water finfish species diversity
- Planktonic diversity
- Wetlands extent, distribution and composition
- Marine diseases indices (*i.e.*, multinucleated spore unknown, dermo, shell disease)

Spatial and Temporal Scales: Regional; annual

### **Monitoring Program**

This program was not created to specifically monitor the indicators chosen. Participants plan to request cooperative assistance from programs already monitoring specific areas of

the region. The data will be collected in one place so that they can be reviewed in total and a decision on the health of the regions ecosystem made. Thus, a monitoring program was not designed or implemented for this program, but programs may be asked to modify their present sampling schemes to include areas not currently monitored.

### **Indicator Implementation**

To ensure that an integrated decision-making system is developed, several participants suggested that groups that are already developed and working (*e.g.*, Gulf of Maine [GOM] Council with financial support for the program coming from elsewhere, Long Island Sound Study [LISS]) be used to get the coordinated monitoring program started rather than starting from scratch. It was felt that these groups could assist in moving the group forward at a quicker pace. Once the common needs for the program are defined, monitoring programs not involved with the group will then be approached to join.

One important item that the participants identified is that when the program is started, a determination needs to be made of quality of data being collected and where data gaps may exist. Quality could be determined through an intercalibration exercise. Then, if needed, the program can move towards standardized methods. Everyone agreed that it is easier to compare data if they are collected in a consistent way. The other important aspect that the group will need to include is a feedback loop.

### **Formal Adoption and Funding**

In most instances, it was agreed that it will be difficult to get ongoing monitoring programs (*i.e.*, GOMOOS, MWRA, LISS, Massachusetts Bay NEP) to change their focus and financially support a new effort. To make this a success, the group will need to secure “buy-in” from Federal (*i.e.*, EPA, Environment Canada, NOAA, and NMFS) and state agency leaders. It was felt that MOUs would need to be developed to ensure that programs do not back out of the group. It was also suggested that MOUs specify the agreement to standardize data collection and analysis methods (where needed).

### **Communication**

The group suggested that this aspect could best be addressed through the use of various groups that are already working rather than having new groups created (*e.g.*, GOM’s Gulfwatch program, GOMOOS, LISS, MWRA, NCA, Mercury Deposition Network). To assist with communication, an implementation plan, program inventory, program description including objectives, and monitoring and data management protocols should be developed to ensure that everyone involved understands how the group will proceed. Then, on a predetermined basis, indicator reports and status of the environment reports should be written to communicate the findings of the group.

### **Monitoring Plan Implementation**

Not applicable.

### **Data Collection and Analysis Plan**

For this program, the stakeholders will have to develop a fairly detailed data collection and analysis plan. Because data will be coming from a variety of programs, the plan will

need to include how the data will be supplied, to whom it will be supplied, how often, etc. At this time, the stakeholders are still working out these issues.

### **Reporting Indicator Findings**

Most workshop participants felt that it is very important to communicate the findings of the program to managers and the public to show value in the efforts made. To support managers in making decisions, the groups noted that the following items would be of assistance:

- Develop periodic assessments and maps.
- Develop data integration and interpretation tools.
- Produce products that have integrated assessments that can draw conclusions and relate changes to stressors.
- Provide a vehicle for workshops, seminars, and other opportunities to share knowledge.
- Provide reports on the socioeconomics of impacts and actions/inactions.

The public, on the other hand, is more interested in knowing things such as “What is the status of the environment (encompasses a variety of spatial scales and ecological compartments); Is it improving or not? What are the scales of influence? What are the trends? What are the responses throughout the system? Are the responses local or regional? By what amount? How sensitive are various biogeographic areas? Are management strategies working? Reports directed at these answers will also be considered for publication.

Documentation of environmental condition may take the form of easily understood “state-of-the-environment” reports. These reports might be geographically based, issue-based, or both. The consensus of the group was that this regional program should not go beyond coordinating, collecting, and disseminating monitoring data. Data interpretation and management planning will be left to the regulators already managing the areas, but the coordinated monitoring group would provide data that regulators would find useful in assessing water quality and management needs. If the regional program provides useful advice and creates a valuable forum for discussion on how each jurisdiction can better manage their waters, or make recommendations for comprehensive management that cannot be handled at the state/province level, regulators should be more open to participation.

### **Revision of the Monitoring Program and Indicators**

Participants of the workshops agreed that an assessment of the overall program should be done on a 5-year basis to ensure that the program is completing its overall goals. This would include an assessment of the issues being monitored, the questions being answered, the monitoring program being used, and the indicators being monitored. In addition to the 5-year reassessment, an internal assessment of the data could be conducted yearly or biyearly through external peer-reviews of products generated by the program.

The information noted throughout this case study came from personal knowledge of the process (personal communication Lynn McLeod, Battelle, 2005) and the following documents:

ANCMS. 2003a. ANCM Summit Fact Sheet #1. February 2003. Available from [http://www.gulfofmaine.org/nciw/Fact\\_Sheet.pdf](http://www.gulfofmaine.org/nciw/Fact_Sheet.pdf)

ANCMS. 2003b. ANCM Workshop Summary Report. February 2003. Available from <http://www.gulfofmaine.org/nciw/ancms2002.asp>

NCIW. 2004. NCIW Workshop Summary. Available from <http://www.gulfofmaine.org/nciw/FinalWorkshopSummary.pdf>